The Integrator

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A Message From The Acting Chief Of The Networks Division

Greetings! Many exciting events have transpired since the last edition of our newsletter this past summer. The Networks Division has continued to make progress in improving TDRS customer support. TDRS Flight 7 was successfully launched in July, recently completed system checkout at 151 degrees west longitude, and will be placed in on-orbit storage mode at 171 degrees west longitude in January 1996. The Cacique Upgrade Project is rapidly moving through the construction phase, and planning for Levels 5, 6, and Post-Level 6 testing is well underway. Level 5 testing will be conducted through the end of this year with Level 6 testing starting next Spring. Post-Level 6 testing with customers is scheduled for next summer in preparation for transitioning the ground terminal to operations. Additionally, there are efforts underway to close the zone of exclusion (ZOE) by placing a Space to Ground Link Terminal on the island of Guam.

During this flurry of construction, testing, and project planning, Danzante continues to provide exceptional support to Space Network customers.

This newsletter issue contains articles on many other projects involving both the ground and space networks such as the expendable launch vehicle agreement with the Air Force, Merritt Island/Bermuda ground station re-engineering, and a new TDRS customer transponder.

The NCC 98 effort is proceeding on track with a Systems Design Review scheduled for November and Critical Design Reviews in December 1995 and February 1996.

I look forward to continuing the successful efforts we have experienced with the Networks Division enhancements and am sure your efforts will continue to achieve significant results.

Phil Liebrecht

FAX 301-286-1724
Phone 301-286-5220
Email - Philip.Liebrecht@gsfc.nasa.gov

White Sands Complex

DANZANTE

Danzante continues to provide customers with excellent support. Here are a few highlights since the last issue of the Newsletter:

- Danzante has provided customer support at an efficiency greater than 99% since transition to operations in December 1994
- As of mid-October, Danzante achieved a customer support efficiency rating of 100% for Shuttle. Only 10 seconds out of 2527 hours of support were lost during the previous three missions.
- All components of Danzante contributed to the successful launch and deployment of TDRS F-7. New software, operational procedures, and training for Danzante personnel were required.

Substantial Progress Made on CACIQUE Upgrade Project

The Cacique Upgrade project has been ongoing since the ground terminal's shutdown last March. The primary construction contractor, Gardner Zemke (GZ), successfully delivered the Ground Communications Equipment (GCE) Room and the TDRSS Operations Control Center (TOCC) in preparation for equipment and cable installation activities. GTE has completed underfloor infrastructure, equipment, and cable installation activities in the GCE and TOCC rooms ahead of schedule.

Retrofits on all three 18.3 meter antennas were completed on schedule as well as the installation of the S-Band TT&C, East, West, and rooftop End-to-End Test (EET) Antennas. A large crane had to be called in to mount the EET antenna onto the roof of the ground terminal in late July.

Formal Level 5 testing of the Cacique Upgrade systems will begin in November after final technical power has been made available by GZ. To minimize schedule slips, Lockheed-Martin Corporation (LMC) began risk mitigation testing and preliminary Level 5 testing with the GCE and Control and Display Computer Network (CDCN) clusters in August. Initial tests have uncovered only minor problems that should not impact the completion of Level 5 and Level 6 Testing.

Did you know....

1) that the diameter of the space to ground antenna *dish* linking TDRS to Cacique Upgrade is 19 meters in diameter? That is over six stories tall!
2) that the old WSGT/NGT equipment used to take over ten seconds to acquire a signal? The Integrated Receivers (IRs) at Cacique Upgrade can acquire the same RF signal as fast as 1/2 second!

Activities planned in the near future include delivery of the full facility from GZ; establishing connectivity with the Nascom IFL and Common Carrier Earth Station; testing the S-Band TT&C, East, West, and Rooftop Antennas; and completing Level 5 Testing.

Additional information regarding the Cacique Upgrade Project is available on the Internet at: http://wscproj.gsfc.nasa.gov/wsc.htm

TDRS Update

TDRS F-7 - Last In The Series

July 13, 1995, marked the successful launch of the STS-70 (Discovery) and deployment of the TDRS F-7 spacecraft. The spacecraft joined its five predecessors, now in orbit, to form the Tracking and Data Relay Satellite System (TDRSS). The launch, originally scheduled for June 8th, was delayed 5 weeks when a pair of woodpeckers (yellow-shafted flickers) attempted to nest in the insulation surrounding the Shuttle's main external tank. The birds drilled approximately 220 holes in the insulation, some of which were the size of a softball. Launch officials decided to roll back the Shuttle to the Vehicle Assembly Building to repair the damage. After the repair, the STS-70 launch was flawless. The TDRS F-7 was placed into geosynchronous orbit by the Boeing-built Inertial Upper Stage.

The TDRS F-7 is the last in a series of geosynchronous orbiting spacecraft built for NASA by TRW of Redondo Beach, California. These spacecraft, which form the TDRSS, provide the primary means for NASA to communicate with and gather data from many of its low-Earth orbiting satellites.

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TDRS F-7

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The F-1, launched in 1983 and retired from general TDRSS services in 1993, provided dedicated support to GRO until early 1995. It is now being positioned to provide support to National Science Foundation activities in Antarctica. The F-2 spacecraft was lost in the Challenger accident in 1986. The F-3 spacecraft, launched in 1988, was retired from general TDRSS service earlier this year and recently replaced the F-1 in providing special support to GRO. The F-4 and F-5 spacecraft , launched in 1989 and 1991 respectively, are presently carrying the bulk of the TDRSS workload. The F-6, launched in January 1993, is being stored on orbit as a back-up for F-4. The F-7 spacecraft, which completed a spacecraft check-out in August is a back-up for the F-5 spacecraft.

While it is the last of the TRW-built TDRS satellites, the F-7 includes some rather significant changes and improvements compared with other spacecraft in the series. These changes include: (1) incorporation of the latest low-noise and power amplifier technologies; (2) new layouts of the MA platform, spacecraft module, and power module; (3) new command and telemetry units, master frequency generator, and DC harnesses; and (4) various changes resulting from removing the C-Band antenna from the spacecraft.

Article by Mike Kelly

Tracking Data Relay Satellite (TDRS) H, I, and J Project Underway

The Government Accounting Office (GAO) has settled the protest of the TDRS H, I, and J contract and Hughes Aerospace is the winner. Hughes began working on the contract on July 11, 1995. The development schedule is:

SRR	January 8, 1996
PDR	July 8, 1996
CDR	January 7, 1997
TDRS H Launch	July 5, 1999
TDRS I Launch	January 3, 2000
TDRS J Launch	July 4, 2000
Project Complete	July 10, 2001

For additional information, please contact Tony Comberiate at 301/286-5678.

Network Control Center (NCC)

NCC 98 - Formerly Known as Service Planning Segment Replacement (SPSR)

The NCCDS/SPSR project has a new scope and a new name. Although efforts are continuing towards developing a flexible scheduling capability for customers, while reducing reliance on propriety mainframe computers and human schedule conflict resolution, the SPSR project is subsumed under the name NCC 98.

NCC 98 is a major upgrade to the NCC Data System (NCCDS) that will include the SPSR and more. NCC 98 will provide customers the capability to schedule enhanced TDRS H, I, and J services and provide the ability to communicate with the NCC via 4800 bit blocks or TCP/IP.

Hardware and software procurements and installation are continuing in support of SPSR development. Workstations and furniture are in place in the Building 13 Software Development Environment and SPSR implementation commenced in October.

Organizational changes have occurred and three focus groups have been established. Jeff Lubelczyk of the Data Systems Technology Division (GSFC Code 520) has been appointed SPSR Development Manager. Dave Berger and Bernie Harris, both from the NCC Project Office (GSFC Code 530.5), will serve as SPSR system architects. Roger Clason, also from GSFC Code 530.5, has been appointed as the NCC System Engineer and will be responsible for overall NCC 98 implementation. A Development Issues forum has been established to tackle significant development and integration issues and a Joint Test Team has been formed to combine NMOS, SEAS, and Code 520 testing resources for integration and system testing. A third team is currently meeting to review baseline requirements and recommend deletions in order to recoup projected schedule delays.

The NCC 98 System Design Review (SDR) was conducted November 30 and covered plans and progress for all major NCCDS subsystems. A technical Critical Design Review (CDR) of the SPSR is scheduled for December 15.

Space Network Elements

Nascom Upgrades in Store

An upgrade to the WSC Nascom interfaces and the Inter-Facility Link is being planned and engineered for early spring of next year to support the delivery of real-time and recorded spacecraft data to the EOS Data and Operations System (EDOS) Data Interface Facility (DIF). Some existing PVC conduit, leading to the General Electric earth station, will continue to be used after removal of old unused twisted pair cables. New excavation and trenching will be required to place two new cables of 144 single mode fibers between the DIF and Cacique. Modifications include a new manhole at the DIF and installation of several new racks at Cacique and the DIF. The existing IFL will be used to interface Danzante through Cacique to the DIF. Low speed data (1 kbps to 10 kbps) will be transferred over the BCP Inc. model 2200 Fiber Optic Transceivers (FOT), while high speed data (10 Mbps to 300 Mbps) will use the new BCP model 2012 (transmit) and 2022 (receive) variable rate FOTs. These variable rate FOTs are a major new development and will eventually replace all fixed rate high speed FOTs in the IFL, thereby meeting the more demanding requirements of new spacecraft.

Nascom has recently unveiled its new internetworking lab in GSFC's Building 3, Room N-21, to help lead NASA's communications support into the next century. The lab will be used to prototype a high-speed IP EOS network; build, test, and prototype equipment needed to move legacy Nascom networks to an IP network; and gain experience in Asynchronous Transfer Mode (ATM) and synchronous optical networks (SONET). Vendor products will be evaluated in the lab, focusing on router technology at first. A device to allow non-IP data to travel on an IP network, named the Frame Encapsulator/Decapsulator (FED), is being designed and tested. A trial AT&T-provided ATM service between MSFC, JPL, and GSFC is being used to build and test equipment, including an ATM Conversion Device (ACD). The ACD and the FED are major stepping stones towards helping move Nascom from proprietary networks to COTS network systems.

Article by Mike Johnson

Busy, Busy, Busy in The FDF!

The FDF has been very busy supporting several STS missions, defining and testing new areas of development that improve FDF's overall support to the Space Network (SN), and making improvements in our computer environment.

FDF recently played a lead role in recommending and coordinating the test activities involved in verifying the feasibility of SN support of non-SN customers. The successful verification of SN support of non-SN customers has opened up new avenues for increased telemetry and possible SN tracking support for projects launching spacecraft that are compatible with the Ground Network (GN), such as WIND, NOAA-J, TDRS/IUS, and TITAN/CENTAUR. Often, a GN compatible spacecraft lacks adequate telemetry and tracking coverage from the GN, due to lack of visibility during the early launch (and at post-separation from the launcher) support phase of the mission. The new SN support scenario has now made it possible for certain projects to increase their coverage during critical phases of a mission. The activities conducted in this area by FDF in conjunction with Flight Dynamics Support Branch (GSFC Code 553) support personnel uphold the NASA philosophy of being innovative and trying new ways of using existing technology.

FDF also participated in the planning and execution phases for testing of the Danzante Doppler data quality when Doppler Compensation is enabled (DCE). FDF recommended the use of test scenarios to avoid any impact to customers who used the Doppler data during testing. The customers that participated in the test were EUVE, GRO, HST, TOPEX, and UARS. FDF provided real-time feedback during testing, and was able to call off the test, if necessary, in the event that serious problems might have occurred. FDF personnel provided input for future testing so that complete and adequate tests can be conducted before the capability is declared operational. This new feature at Danzante has certainly opened up the opportunity for customers to receive increased good quality Doppler data that can be used in the orbit updates. Additionally, it will allow more flexibility to the Customer POCCs since POCC functions can be conducted during DCE for longer time spans without jeopardizing tracking services.

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Busy in the FDF

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In summary, this new feature at Danzante makes possible larger amounts of tracking data per event, as well as easier procedures for the POCC personnel.

In addition, during post-Level 6 testing with Danzante, FDF personnel recognized the potential for a new vector processing capability. This new vector processing capability was accomplished by modification and significant improvement of the Danzante Type 8 interpolation algorithm. This change affected the backup and primary Shuttle support modes that use stationary (Type 8) vectors to approximate actual trajectories. FDF personnel proposed that the Danzante processing algorithm be changed to allow the inclusion of nonzero Earth-fixed velocity components in "stationary" vectors. The FDF analysis demonstrated that this change would result in much more accurate TDRS pointing angles, good Doppler compensation values, and a much simpler and quicker backup vector selection process in the FDF. Another advantage would be the ability, for the first time, to generate usable TDRS pointing angles and Doppler data for ditch contingencies and Emergency Mission Control Center (EMCC) end-of-mission landings. The effort then evolved into a highly successful multi-element team enterprise. The recommended change and its advantages were discussed with WSC Project, Code 530, Johnson Space Center (JSC), and Danzante personnel; feasibility testing was performed; and the change was implemented and tested at Danzante in March 1995. Since then, the new capability has been applied with great success in the generation of backup vectors for all Shuttle contingency modes, including return-to-launch-site (RTLS), Bermuda-abort-landing (BAL), East Coast-abort-landing (ECAL), transoceanic-abort landing (TAL), abort-once-around (AOA), and EMCC landings. It is also being used routinely for nominal Shuttle launch and landing support, and was used successfully in the SN support of Titan/Centaur launches.

In addition, FDF is currently involved in an effort to move from a mainframe computer to a distributed workstation computing environment. The target date for completion is November 1996.

Information about the FDF can be found on the WWW at: "http://fdd.gsfc.nasa.gov/fdd550.html".

Article by Michael Dolan

Upgrades Slated for User Planning System

Significant changes are on the horizon for the UPS project. Release 9, which is a maintenance release, is scheduled for operations approximately 90 days following the XTE launch, which is currently scheduled for early December. This release corrects a number of Discrepancy Reports and implements Enhancement Requests for XTE.

A hardware replacement study is underway and a recommendation for a new platform is scheduled for this month. The current DEC Ultrix platform is out of production. The study will consider supporting multiple platforms, a generic GUI builder, and a recommended Database Management System. The new platform and associated Release 10 are scheduled for rollout in October 1996.

In support of NCC 98, the UPS project is making great strides towards providing a flexible scheduling capability for customers. The new effort, termed UPS 98, recently completed a successful Operations Scenario Review where derived requirements and prototype customer interfaces for mission setup and schedule planning were reviewed. This activity, and coordination with customers and NCC personnel, will culminate in a Systems Requirements Document to be reviewed at the System Requirements Review in January 1996. Delivery of the new system is currently scheduled for November 1997.

Customers are greatly encouraged to participate in the January 1996 Systems Requirements Review (SRR).

More information can be obtained from Les Wentz at (301)286-5563.

Additional information regarding UPS is available on the Internet at: http://isolde.gsfc.nasa.gov/ups/welcome.html

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SPACE NETWORK CUSTOMERS

Progress Made on Three EUVE Initiatives

The Explorer Platform and its scientific payload, Extreme Ultraviolet Explorer (EUVE), continue to perform admirably. All spacecraft subsystems are nominal and quality sources are being observed. The Flight Operations Team is currently involved with three mission initiatives in addition to routine flight operations: the conversion of ground system software to Transportable Payload Operations Control Center (TPOCC), the development of an autonomous computer system (APOCC) to support select aspects of operations, and the Flight Testbed for Innovative Mission Operations program (FTB-IMO).

The TPOCC conversion effort, although behind schedule, is progressing with the September delivery of Release 1.1. The FOT is conducting parallel telemetry operations, validating converted ground procedures, and testing a limited portion of spacecraft commands with our simulator. The TPOCC is expected to be operational in the spring of 1996. The APOCC system recently completed a successful requirements review and will employ the TPOCC tool suite, the Generic Inference Engine (GENIE), to monitor spacecraft health and safety during the off-shifts. An implementation in summer of 1996 is targeted, but will depend on the operational acceptance of TPOCC. Several experiments have been accepted into the FTB-IMO program, which allows on-orbit testing of emerging technologies. These experiments include SELMON, a selective telemetry monitoring system developed at JPL, and a heuristic science scheduling system developed by the University of California at Berkeley. The experiments are expected to begin later this year.

Article by Ken McKenzie

HST Readies for the Next Servicing Mission

The Hubble Space Telescope is in its fifth year on orbit and continues to collect great science data. In August HST's Wide Field Planetary Camera II observed four possible new objects orbiting Saturn which are believed to be moons of Saturn. In September, HST was used to make observations of Jupiter to study continuing changes in the atmosphere of the planet since the Comet Shoemaker-Levy impact in July 1994. HST was also used to observe the bright new comet Hale-Bopp.

The next HST Servicing Mission is scheduled for February 1997. Testing for this mission officially began in August with the successful execution of the Servicing Mission Ground Test (SMGT) #21. This test verified the ability of the ground system to support the commanding and data dumps for the new science instruments being installed in the next Servicing Mission. SMGT #21 was the first of 30 servicing mission tests currently scheduled. These tests include 3 ground systems string tests, 11 flight hardware tests, 7 JSC Interface Performance Activity tests, 5 KSC Performance Demonstration Tests, and 4 End-to-End tests. These tests will require a great deal of hard work, both from HST project personnel and Mission Operations and Data Systems Directorate (Code 500) institutional support personnel. The next year and a half should be exciting and challenging for all involved.

HST Project Schedules and information can be found on Internet at :
http://saturn1.gsfc.nasa.gov/440/

Article by Barbara Pfarr

Upper Atmosphere Research Satellite Still Effective Despite Power Problems

The Upper Atmosphere Research Satellite (UARS) embarked on its fifth year of on-orbit operation in September. With careful planning, monitoring, and control by the Flight Operations Team (FOT), the spacecraft has demonstrated recently that it can support the full complement of science payload instruments in various modes, despite a stationary solar array. The FOT continues to work closely with the science community in the development and implementation of viable plans for managing the UARS power subsystem and instrument loads.

Danzante continues to provide excellent support for all UARS real-time operations. Test modules have been submitted for participation in Level 6 testing of the Cacique Upgrade.

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UARS

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The FOT looks forward to testing with Cacique from the new UARS Mission Operations Room in Building 32 at Goddard Space Flight Center.

Please direct any questions or comments to John Speer at 286-1258.

Article by Erik Berger

Johnson Space Flight Center's New Mission Control Center in Action!

The Johnson Space Flight Center's new Mission Control Center (MCC) recently supported STS 69 and 70 for on-orbit operations. In July, STS-70 deployed the TDRS F7 satellite, which has recently completed system checkout. The old control center will support its last mission, STS 72, scheduled for January 1996. STS 75 is scheduled for February 1996 to deploy the Tethered Satellite System (TSS) and the US Microgravity Payload (USMP). This flight will mark the first full mission out of the new MCC.

STS 74, which flew in November, was the second Shuttle/Mir rendezvous mission. JSC is currently planning to take on-orbit support from the Cacique Upgrade ground terminal in May of 1996.

Marshall Space Flight Center Supports New Concepts on Shuttle Mission

Much of the construction at the Huntsville Operations Support Center (HOSC) has now been completed. The administrative addition to the building was ready on schedule and is now fully occupied. The portion of the building which will house the International Space Station Alpha (ISSA) Payload Operations Integration Center (POIC) is 80% complete and has a readiness date of 11/30/95. Also completed is the Data Operations Control Room (DOCR), which provides a centralized control area for the MSFC Operations Support Team (OST).

MSFC is also supporting the United States Materials Laboratory (USML)-2 mission, which was launched aboard the Shuttle on October 20, 1995, and is ongoing as this article is written. Several new concepts are being utilized on this mission for the first time. One of them is Hi-Pac Video, which is a method of downlinking Orbiter TV and Science Experiment camera views digitally via the High Rate Multiplexer (HRM). Normally the HRM channels are used for Science Experiment digital data, but on this flight six channels were reserved for Hi-Pac Video. Up to six camera views can be sent down to the ground while we still receive digital data on the remaining experiment HRM channels. Of the up to six channels sent to MSFC, up to three of these channels can be routed to the User Operations Facility (UOF) at Lewis Research Center (LeRC) in Cleveland, Ohio. It is estimated that between 594 and 630 hours of video will be downlinked via Hi-Pac during USML-2.

The other new feature being utilized on USML-2 is Ground-to-Air Television (GATV), which is exactly what the name implies. MSFC has the capability to uplink any video source which is available on the HOSC video matrix switch to the Orbiter via JSC/Houston. This feature utilizes 128 Kilobits per second (Kbps) of the 216 Kbps Ku-Band forward link. GATV video can be originated from the MSFC POCC, JSC Flight Activities Office Mission Planning Support Room (FAO MPSR), or any external National Television Standards Committee (NTSC) source via JSC TV, MSFC TV, or MSFC HOSC. All video to be uplinked to the crew must be approved by the JSC Flight Director. The standard air-to-ground voice uplink may be utilized to provide audio for the GATV video uplink.

The MSFC home page can be reached at http://www.msfc.nasa.gov; another handy reference is: http://shuttle.nasa.gov.

Article by Mike Blum

TOPEX/POSEIDON Data Available on the WWW

TOPEX/Poseidon flight operations continue routinely. Oceanographic data have been taken for more than 112 ten-day-long ground track repeat cycles. The Project celebrated its third anniversary of launch on 10 August and we are anticipating up to three more years of flight.

All spacecraft operations and SN support functions have been routine. Acquisition of data, delivery to the POCC, and generation of data records for the investigators have all been completely nominal.

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TOPEX/POSEIDON

(Continued from page 7)

The investigators continue to monitor all of the recovered data, looking for both long-term global changes to the sea surface and shorter-termed localized phenomena like the El Nino/Southern Oscillation. A complete library of TOPEX/Poseidon data dating back to September of 1992 is available on the World Wide Web. The data appear as image files representing five global measurements taken every three days: dynamic topography, sea surface variability, significant wave height, wind speed, and precipitable water vapor. Software is also available for "do-it-yourself" animation. The files and software can be found in the "Image/information archives" section of the JPL home page (URL http://www.jpl.nasa.gov). We are also developing a set of operations-oriented pages for the Web that should be available by the next issue of The Integrator.

Article by Terry Adamski

ERBS Still Performing Well

The project celebrated its eleventh anniversary on October 5, 1995, and the spacecraft is quickly approaching a milestone of 60,000 orbits (17,000 orbits on a single degraded battery).

The Earth Radiation Budget Satellite (ERBS) is performing nominally. The instruments for the Earth Radiation Budget Experiment NonScanner (ERBE-NS) and the Stratospheric Aerosols and Gases Experiment (SAGE-II) continue to gather valuable science data. The ERBE-NS instrument supports climate studies by observing the Earth's energy balance and the SAGE-II instrument observes quantities and qualities of upper atmospheric aerosols and gases, particularly ozone. A single degraded battery is supporting the entire spacecraft power load. The battery is performing well, however, and shows no signs of further degradation.

Operations with Danzante (STGT) have been routine. The recently corrected loss of signal experienced during critical yaw maneuvers was due to out-dated EIRP values. Due to new Danzante capabilities regarding re-acquisitions, the duration of the re-acquisitions was reduced by nearly 40% even though the trend in the frequency of late acquisitions continues.

Spacecraft power constraints will prohibit the ERBS project from participating in Level 6 testing with Cacique (WSGTU). The project is very pleased with the performance of Danzante and network personnel, and looks forward to continued support from the White Sands Complex.

For additional information, please contact Mr. Robert Sodano, ERBS Project Operations Director (NASA code 513) at 301/286-6506.

Article by Rob Bote

GRO Data Enables Discovery of New Class of Gamma Ray Source in Our Galaxy

The Compton Gamma Ray Observatory has been in orbit now for 5 years and continues to make new findings with each pointing. GRO is the second in NASA's series of Great Astronomical Observatories following the Hubble Space Telescope. The gamma rays we detect are produced in the most violent sites in the universe, including solar flares, supernova explosions, pulsars, quasars and the mysterious gamma-ray bursts.

This year discoveries have been made using GRO and radio telescopes of a new class of object in our Galaxy, namely superluminal jet sources. These are transient sources that have approximately monthly outbursts for about a year and then disappear from view. When they are in outburst, they are the brightest objects in the gamma-ray sky. The amazing thing about the new sources is that they have jets of material that squirt out after most of the gamma-ray outburst. These are seen in the radio band using ground-based telescopes. Small knots of radio emission are seen to spread out from the source, sometimes even moving apparently faster than the speed of light. This is an optical illusion based on effects of Einstein special relativity. The actual blobs of gas are moving less than, but close to, the speed of light. Such effects have been seen before in extragalactic quasars, but never before in galactic sources.

For additional information contact:
Robert Sodano/513
CGRO Operations Manager,
286-6506

Article by Dr. Neil Gehrels

Long Duration Balloon (LDBP)Project

LDBP Vehicle Capabilities:

- Suspended payloads up to 6000 pounds (2700 kg)
- Altitudes up to 130,000 feet
- Controlled via automated ballast and helium venting system with manual override
- Telemetry provided by TDRSS, INMARSAT-C, UHF and Argos

LDBP Missions

- 12-day single circumpolar trajectories:
  - Antarctica in December and January (78 degrees South latitude)
  - Canada-to-Greenland in June and July (68 degrees North latitude)

The Canada-to-Greenland Long Duration Balloon mission scheduled for June of 1995 was canceled due to inclement weather. The next LDBP mission to utilize TDRSS will be the Canada-to-Greenland mission scheduled to begin in June 1996,

PORTCOM Technology Continues Development

The Portable TDRSS Communicator (PORTCOM) Project continues its evolution in further development of the Transmitter and Receiver. The design now includes handling higher data rates as well as a voice capability. The data rate is now 9.6 Kbps with 1/2 rate convolutional encoding (19.2 Ksps) rate to TDRSS. Both the receiver and transmitter continue to use the original 3 inch antenna. The transmitter power remains at one watt. One transmitter and receiver pair have been upgraded to include the higher data rate and voice capabilities. Several tests have been conducted successfully demonstrating the new capability. Further evolution is planned.

Test plans are being developed to interface the receiver-demodulators at the White Sands Complex (WSC). The purpose of the tests is to evaluate use of PORTCOM technology in support of the envisioned TDRSS Demand Access mode of operation, as well as learn more about the interface to WSC. Demand Access is a mode of SN operation being considered using the TDRSS MA Service, both forward and return, without the need for scheduling the service by customers. Currently TDRSS customers are being provided with a questionnaire to determine the viability of this mode of operation.

One of the PORTCOM Transmitters was recently transferred by GSFC to the National Oceanic and Atmospheric Administration (NOAA) Pacific Marine Environmental Laboratory in Seattle, WA for testing as part of the NOAA climate research in the Pacific Ocean. NOAA has received approval to use the TDRSS MA Service to receive data transmitted from approximately 70 anchored ATLAS buoys located in a rectangular grid ±10° North and South of the equator and from 90° West to 130° East. The data received from these buoys is important to weather prediction since most of the continental US weather is formed in the Pacific basin. NOAA currently uses polar orbiting satellites to receive data transmitted from the buoys at random intervals. TDRSS support of the ATLAS buoys will provide a major improvement in the timeliness of data received, support a meaningful increase in data rate over the present 300 bps, and enable immediate signaling of Tsunami Warning (underwater earthquakes). NOAA lab tests of the PORTCOM transmitter began in October of this year. A phase over to TDRSS support of NOAA buoys is expected in 1997.

Article by Art Jackson & Lou Koschmeder

Around the Mission Operations and Data Systems Directorate

NASA Signs TDRSS Support Agreement with TITAN IV/CENTAUR

NASA and U.S. Air Force representatives recently signed a nine-year agreement for the Air Force's Titan IV/Centaur launch program to receive communications support from TDRSS. The Air Force plans to make TDRSS the primary tracking and data acquisition system for that portion of the Titan IV/Centaur launch period which is not covered by existing ground sites.

Plans are for TDRSS to provide the services to the Air Force's Milstar satellite launch scheduled for November from Cape Canaveral. After final checkout on the Milstar mission, the Air Force intends to make TDRSS the primary tracking and data acquisition system for Titan IV/Centaur launches for the duration of the agreement.

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NASA Signs TDRSS Support Agreement

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This support of the Titan IV/Centaur launches marks the first time that TDRSS will be used operationally to support an expendable launch vehicle. TDRSS communication support is expected to reduce support currently provided by the Air Force's Advanced Range Instrumentation Aircraft (ARIA) for major phases of the Titan IV/Centaur launches. TDRSS was chosen by the Air Force as the most cost effective alternative for providing launch support.

Eleven Titan IV/Centaur launches are planned for the next nine years. TDRSS support is expected to save an estimated $14 million for this period.

An Expendable Launch Vehicle (ELV) Workshop was conducted in October 1994 to present to the ELV community the TDRSS capabilities for launch support and to determine if there was interest in utilizing TDRSS. As a result, the Titan IV/NASA agreement was established and the "Steering Group for TDRSS Business Development" has been chartered under GSFC Codes 501 and 502 chairmanship to address the procedures for disseminating information to future customers. For example, the X-33 and X-34 launch vehicle programs, the national Polar Orbiting Environmental Satellite System, and military organizations have expressed interest in using TDRSS support.

The commercial sector for the Atlas-Centaur program has submitted a formal request and Mission Requirements Request to NASA Headquarters for TDRSS support to commercial launches. Demonstrations are scheduled for February of 1996. This could lead to using TDRSS support for up to eight Atlas-Centaur launches per year.

Discussions are also taking place with the Delta launch vehicle program and NASA's Code 470 to explore using TDRSS support.

The GSFC Mission Operations and Data Systems Directorate plans to continue these growing beneficial relationships with the new customer communities.

For more information contact Roger Flaherty at (301) 286-8422.

GSFC Networks Division Prepares For The Future

The Networks Division (GSFC Code 530) is currently conducting a Strategic Planning effort to determine the course of Division activities for the next 5-10 years. This activity is of utmost importance, especially considering the changes that have recently been proposed for NASA as a whole. Our intent is not to wait until upper level plans are in place and be driven by those plans, but to formulate our own future by influencing those upper level plans.

The planning process was designed and put in place last May. Participants include personnel from throughout the Division at the section, branch, office, and division management levels. Branch and Office heads initiated the process by identifying several critical questions that needed to be answered for effective planning to take place. An Information Collection Team was formed to research these questions and provide additional insight to management. Another team then utilized this information to construct some possible scenarios for the future of the Division. Division managers are currently analyzing the implications that emerged from the analysis of the scenarios as they determine the direction the Division should take in the future. They will formulate Vision and Mission Statements for the Division as well as specific goals and objectives.

It is anticipated that documents describing the Strategic Plan and corresponding Implementation Strategies will be available for distribution in the next few months. The execution of the Plan by the branches and offices will be strictly monitored by the Division, following guidelines outlined in the Implementation Strategies. Both the Plan and Implementation Strategies will be updated continually as circumstances change.

ESDIS Office Leading A Reshape

The ESDIS (Earth Science Data & Information System) Project is currently leading a front-end architecture reshape activity with support from institutional and Earth Observing System Data & Information System (EOSDIS) elements. The revised front-end data system, called the Adaptive Downlink Architecture, will affect interfaces to institutional entities and EOSDIS elements such as the

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ESDIS Office Leading A Reshape

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EOSDIS Core System (ECS), EOSDIS Backbone Network (EBnet), and the EOS Data and Operations System (EDOS). This modification will make optimum use of current EDOS and ECS design while streamlining processing, providing for either TDRSS or X-band Ground Station high rate links, revising Level 2 requirements and operations concepts, and producing significant cost savings.

An ECS Critical Design Review (CDR) for the Science Data Processing Services and the Communication & System Management Services Release A was successfully conducted August 14-18. The ECS Flight Operations Services CDR for the combined Releases A & B was held October 16-18. Additional reshape activities will proceed over the next few months. Substantial impact on the ECS is expected, and will be reflected in subsequent design releases.

Current status and information about ESDIS may be found on its Internet homepage:http://spsosun.gsfc.nasa.gov /ESDIShome.html

Article by Gene Smith

IMACCS Project Complete

A successfully functioning, commercial, off-the-shelf (COTS)-based ground support system was developed in 90 days. The system is called the Integrated Monitoring, Analysis, and Control COTS System (IMACCS). IMACCS was implemented in the April '95 to July '95 time frame as a part of the Renaissance group consisting of SEAS and GSFC personnel, with System Engineering Facility support from NMOS personnel. The Renaissance group is supported by the Goddard Space Flight Center (GSFC) Mission Operations and Data Systems Directorate. IMACCS was designed to operate NASA's Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX). IMACCS was conceived specifically to build on previous experience in test-bed evaluation of COTS products. The IMACCS project integrated a typical set of such tools, connected them to live tracking and telemetry data from a real, on-orbit satellite, and performed shadow mission operations.

The IMACCS project assessed the completeness, robustness, and performance of a COTS-based ground system. A key constraint was to build the system within 90 days of project approval. The project, completed within the allotted time, compared the requirements satisfied, costs, and operations against the currently operating ground system. Operational tests using actual scenarios and data in a shadow mode on the simulator showed complete fidelity to the operational data dumps. Demonstrations to the Flight Operations Team (FOT) elicited favorable comments on the capabilities that had been developed.

Based on the article "IMACCS: AN OPERATIONAL, COTS-BASED GROUND SUPPORT SYSTEM PROOF-OF-CONCEPT PROJECT, by M.R. Bracken, S. L. Hoge (GSFC) and C. Sary, R. Rashkin, R. D. Pendley , R. D. Werking (CSC).

Coming Attractions

Major Milestone Achieved in International Space Station Testing Program

A major milestone was recently achieved as the first SN Communications and Tracking (C&T) compatibility test with International Space Station (ISS) Program hardware was successfully completed. A three phase interface functionality test was completed with the ISS S-band Design Verification Test Model (DVTM) in both the forward and return directions at high and low data rates.

Testing was conducted at the Lockheed Martin Communications System (LMCS) facility in Camden, New Jersey, where the DVTM and associated ground support equipment were housed within a mobile trailer. A Goddard Space Flight Center Compatibility Test Van (CTV) was co-located at the facility to provide initial SN simulation as well as the RF link to TDRS East. The increasing level of testing included an initial SN simulation with the CTV, a hard-line test between the DVTM and CTV, an S-band DVTM-TDRSS RF test and finally an actual RF demonstration using the test model S-band high-gain horn antenna. Testing was controlled and monitored from the Network Control Center (NCC) and Danzante. Additional testing outside the planned test script included STS/ISS RF Interference testing, and S-band low-gain antenna testing. A live audio demonstration was also successfully performed with participation from astronaut Michael Clifford.

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International Space Station Testing

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With the successful completion of S-band testing, preparation for Ku-band testing with the SN is under way. The Ku-band DVTM will be tested with TDRSS as early as March 1996 from the WSC. S-band and Ku-band compatibility testing with Qualifications Models is tentatively scheduled for August 1997 from the Seal Beach, CA, Rockwell International facility.

XTE Ready for Launch

The X-Ray Timing Explorer (XTE) project continued its launch preparations with Mission Simulation # 4 on July 17-20, 1995. This was a very successful end-to-end test. The test included the launch, early orbit, normal mission day, and contingency scenarios with the following test elements:

- The XTE spacecraft in Hangar AO at Kennedy Space Center
- The Space Network (TDRS East via the MILA-Relay)
- The Ground Network (MILA) and the Deep Space Network (Goldstone)
- The Mission Operations Center and Science Operations Facility at Goddard
- Principal Investigator facilities at MIT, UCSD, and GSFC.

During the Mission Readiness Review in early August, the XTE Project stated that the XTE spacecraft, instruments, and Ground System were ready for an August 31, 1995 launch date. Due to anomalies with the launch vehicle, this launch date was subsequently postponed until early December.

For more information, contact

J.B. Joyce, XTE Mission Operations Manager.

Article by J. B. Joyce

Tropical Rainfall Measuring Mission (TRMM) Progressing Toward 1997 Launch

The TRMM project recently received delivery of the Microwave Imager at GSFC and is progressing on schedule toward an August 1997 launch. Integration of the data and power subsystems with the observatory is complete and the TRMM team will begin integration and testing of the attitude control subsystem next. The Clouds and Earth's Radiant Energy System (CERES) team also completed testing of the CERES instrument and is preparing for delivery on October 16, 1995. The development of the TRMM ground system software (Mission Operations Control Center and Science Data Processing System) is also progressing on schedule.

For additional information, please contact Tom La Vigna at Tom.Lavigna@ccmail.gsfc.nasa.gov.

Networks '95 Workshop Is Now Networks '96 Workshop

Due to the furlough of civil servants, the Networks '95 Workshop has been renamed and rescheduled. It is now the Networks '96 Workshop and will occur on January 30 and 31, 1996. The workshop will be conducted in the Building 3 auditorium at Goddard Space Flight Center. Topics include:

- NEW TECHNOLOGY APPLICATIONS
  - Nascom Transition to Internet Protocol from the 4800 bit block
  - IMACCS, a COTS-based Ground Support System
- SPACE FUTURES
  - Mission-to-Planet-Earth
  - Landsat-7
  - Expendable Launch Vehicles
  - Space Station
- SPACE NETWORK
  - -Flexible Scheduling - NCC 98
  - -TDRS H,I and J
  - -Cacique Upgrade

Check the GSFC Networks Division Internet Home Page for an announcement and the two day agenda: "http://www530.gsfc.nasa.gov/events/networks96.html"

Ground Station Re-Engineering Planned for Meritt Island and Bermuda

Code 530 is laying the infrastructure for the re-engineering of the Merritt Island and Bermuda ground stations.

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Ground Station Re-Engineering

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Code 530 is planning to employ the OMCS technology at the Merritt Island and Bermuda ground stations. The re-engineering effort involves replacing the recorder and the Telemetry and Command Data System (TCDS) hardware with modern equipment that can easily interface to a network backbone. The current plan is to place an OMCS workstation at the Merritt Island and Bermuda ground stations. The Operational Monitoring Control System (OMCS) is a COTS package that is in use at the NCC, Danzante, and Australia ground stations. The OMCS allows operators at any of these ground stations to monitor and control the equipment at one of the other ground stations.

For additional information, please contact Frank Stocklin at 301/286-6339.

McMurdo TDRSS Relay System (MTRS) to be Built in Antarctica

The MTRS will provide a relay capability for data received by the new RADARSAT facility in McMurdo - primarily for polar orbiting missions and launch vehicles. Once the data arrives at the WSC, it can then be distributed to various Continental U. S. (CONUS) locations. The initial installation is considered a "proof of concept," i.e. it is expected that at least one year of reliable support should be accumulated before it is considered operational.

The MTRS has the capability to relay up to 300 Mbps of return data and a limited forward link of 32 Kbps (extendible if needed). The initial application is for 105 Mbps of RADARSAT and Earth Resource Satellite (ERS) 1&2 data. The system has two main components - the RF equipment at Black Island in view of TDW at 174 degrees west longitude, and the control center located in McMurdo some 34 KM north of Black Island. The system design allows complete status and control from a single console by one operator including failover switching, full operations, and power down if necessary. All system testing was completed this past summer at GSFC. Operations are scheduled to begin in February 1996.

Article by Frank Stocklin

TDRS Zone Of Exclusion to be Closed

A planning effort is underway to close the TDRS Zone of Exclusion (ZOE). The ZOE is the volume in low earth orbit which does not have TDRS coverage due to the Earth's curvature and TDRS east and west locations. The effort is to examine the feasibility of placing a Space-to-Ground-Link Terminal (SGLT) on the island of Guam with connectivity through the White Sands Complex to "close" the ZOE. Code 530 has examined the available sites on the island and is in the process of recommending a site for the implementation.

SGLT-6, with connectivity through the Cacique Upgrade, is the likely candidate for placement on Guam, with TDRS F-3 at 275 degrees west longitude providing the communications link to SN customers. The current approach is to add Multiple Access (MA) capability to SGLT-6 for use on Guam. The SGLT will be assembled, integrated, and tested at the White Sands Complex in the Guam configuration before it is shipped. Installation, integration and test will follow at Guam.

The White Sands Complex Project Office at the Goddard Space Flight Center is currently working the implementation approach. The goal is to have the Guam Remote Ground Terminal operational by September 1997, prior to the last Shuttle/Mir mission.

STARLINK

THE STARLink program, sponsored by NASA Ames Research Center, is continuing with its test program involving the ER-2 aircraft and the Space Network. Plans are for the aircraft system, which sends imagery via TDRSS to its customers, to be operational in the near future.

Images from the program are available on the internet at: http://hawkeye.arc.nasa.gov

Technology Update

TDRSS Communications for Small Satellites

The small satellite community is currently unable to use the Space Network since the receiver power consumption of the 2nd and 3rd generation TDRSS user transponders is too large for the limited capacity of small satellite power systems.

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TDRSS Communications

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GSFC's Networks Division (Code 530) and Electrical Engineering Division (Code 730) are collaborating on the development of a 4th generation transponder which is aimed at achieving a power consumption and weight comparable to the GN-only transponders currently being flown by the Small Explorer (SMEX) Project. The 4th generation transponder will be an S-Band transponder capable of working with TDRSS or ground terminals. This will allow a mixed mode of operation where a project can use TDRSS for command, housekeeping telemetry, and tracking and dump their high rate science data (2-3 Mb/sec) to a ground station using the same S-Band omni antenna in both modes.

For customers seeking to use TDRSS for both TT&C and science data transfer, the 4th generation transponder will provide an optional Ku-Band signal source. Together with an external Ku-Band HPA and phased array antenna, this Ku-band signal source will allow a small satellite to dump 2-3 Mb/sec of science data to TDRSS with roughly the same transmit power consumption as dumping to the ground. The use of Ku-Band and the TDRSS KSA service provides additional gain allowing small satellite customers to overcome the path attenuation to geosynchronous orbit with only a small body-mounted antenna. The array will electronically steer up to 30 degrees from boresight providing ample contact time with TDRSS - far greater than would be available from a ground station. It will have an envelope not greater than 12" x 12" x 6" and will attach to the side of the spacecraft. GSFC Codes 530 and 730, with support from NASA Lewis Research Center, are collaborating on the development of this phased array. This innovative operations concept will lead to cost savings in prelaunch testing, launch and early orbit support, spacecraft control and monitoring and data transport. Scheduled to be available in 1999, the Ku-band phased array, coupled with the 4th generation TDRSS user transponder, will eliminate dependence on ground stations and provide flexible and low-cost Space Network-only mission operations.

Article by Dave Zillig

Charge Coupled Device (CCD) Signal Processing Technology

Over the last ten years, NASA Headquarters (Code O) has funded MIT/Lincoln Laboratory to develop charge-coupled device (CCD) signal processing technology for TDRSS receiver applications. This work was initially used to validate the imposition of a 1-second PN acquisition time in the Danzante Integrated Receiver (IR) specification. Since then, the CCD correlator chips designed by Lincoln Laboratory have been used in advanced receiver designs by Stanford Telecom for the Balloon Class TDRSS user transponder, a prototype for a replacement receiver for GN stations (which is also suitable for low-cost ground terminal applications), and for a universal (TT&C and customer services) receiver for future SN modernization. Because of the advanced receiver's dual capability (SN & GN) and fast acquisition over a wide range of frequencies, it is especially adaptable for supporting GN customers (ELV's, upper stages, GN-only spacecraft, etc.), where possible, via the WSC Intermediate Frequency interface. Most recently, the CCD chip was used in the ten receivers built for the PORTCOM project.

Code O's investment in CCD signal processing technology and application development has been very fruitful to date but the future of this technology looks even brighter. Portable, battery-operated TDRSS transceiver applications such as PORTCOM, NOAA buoys, search and rescue transceivers and Department of Energy remote data collection platforms would all benefit greatly by reductions in receiver power consumption. Lincoln Laboratory has recently proposed an evolutionary upgrade to the current CCD chip which would produce revolutionary results. The new chip would significantly reduce the static power consumption and incorporate the Analog-to-Digital (A/D) converter chip onboard the CCD chip where it would operate in the charge domain, further reducing the power consumption. It is roughly estimated that the 1-watt CCD and 1-watt A/D chip could be replaced by a CCD correlator chip with a digital output which would consume about 115 milliwatts. Further power reductions could be achieved by replacing the general purpose Digital Signal Processor (DSP) chips in the current receiver design with a simplified digital Application Specific Integrated Circuit (ASIC) allowing the low-power CCD to do the algorithmic processing in future miniaturized, battery-powered transceivers or transponders.

Article by Dave Zillig

LANDSAT-7 Automated X-Band Ground Station Being Built

The Landsat-7 Spacecraft, scheduled for launch in 1998, is the latest of the Landsat series of earth resources satellites. The Landsat-7 Project, GSFC Code 430, has requested that the Networks Division, GSFC Code 530, develop and integrate the Landsat-7 Ground Station (LGS). The LGS will be located at the Earth Resources Observing System (EROS) Data Center (EDC), Sioux Falls, South Dakota. The LGS will be the primary Landsat-7 ground station for capturing the Landsat-7 Enhanced Thematic Mapper (ETM) X-Band downlinks. The LGS will receive, demodulate and bit synchronize the data, and forward the data to the co-located Landsat-7 Processing System (LPS) for recording.

The LGS team is composed of the GSFC Radio Frequency Systems Section (Code 531.2), AlliedSignal Technical Services (ATSC), and Raytheon Services Company (RSC). ATSC is responsible for system design, integration, installation, and testing. RSC is tasked with the procurement and logistics activities. Once the station is installed and tested, the LGS will be turned over to EDC for operations.

The LGS will be constructed from Commercial Off the Shelf (COTS) equipment. The major procurements are the Antenna System, RF and Telemetry Equipment, Timing System, Matrix Switch, and Monitor and Control System (MCS). The subsystems, less the antenna, will be integrated and tested at GSFC, in early 1996. The LGS equipment will be shipped to EDC and integrated with the antenna system in late 1996. The schedule is based on the requirement for the LGS to be operational one year before the launch date.

The LGS will be controlled by the proven FactoryLink software used in the McMurdo (Antarctica) TDRSS Relay Project. The control system will permit an entire satellite pass to be taken automatically. In routine operations, a single operator is planned to run the LGS and LPS simultaneously.

Article by Armen Caroglanian

Look for more network news and activities in the GSFC Networks Division's home page on the World Wide Web (WWW).

(http://defiant.gsfc.nasa.gov/530homepage.html)

Milestone Updates

The Space Network/White Sands Complex Transition Major Milestones and Reviews chart is provided with this newsletter.

With this revision, the timeframe for the chart is now 1994 through 1997. Two important activities have been added; they are the modifications to the ground terminals to support TDRS HI & J, and the implementation of the Guam Remote Ground Terminal (GRGT). The start date for the Cacique Upgrade Level 6 testing has been updated as well as the TDRS constellation configuration.

If you have questions, comments, or suggestions for The Integrator newsletter, please contact:

Lynn Myers via:
e-mail: lynn.myers@gsfc.nasa.gov
phone: 301-286-6343
fax: 301-286 1724